

## Are the levels of toxic chemicals in Casco Bay sediments changing over time?

CBEP Goal: Reduce toxic pollution.

### Why Is It Important to Measure the Levels of Toxic Chemicals in Casco Bay Sediments?

When the sediments of Casco Bay were first analyzed in 1980, scientists were surprised to learn that contamination by heavy metals and organic contaminants was widespread. Toxic chemicals enter the Bay through multiple pathways (see the diagram on p. 36), often becoming attached to sediment particles. Once in the sediments, toxics can either break down over time or become buried under newer layers of sediment, where burrowing or deposit-feeding organisms, or dredging by humans, can return them to the surface. Pollution exposure adversely affects the benthic (bottom) community, making organisms sick, reducing the number of species present, and increasing the predominance of hardy, pollution-tolerant organisms.

Organisms that inhabit the benthic sediments play an important role in the marine food chain, recycling organic matter and serving as a food source to groundfish, lobsters, and crabs. By ingesting smaller organisms that have accumulated toxic chemicals from the sediments, fish and larger crustaceans may experience inhibited growth and reproduction, increased vulnerability to disease, and even death (US EPA 2006). Humans who consume seafood contaminated by toxic chemicals can be at risk as well. For example, the dioxins present in Casco Bay, a legacy of the pulp and paper industry, have resulted in elevated levels in the livers – the tomalley – of lobsters. A public health advisory against eating tomalley has been in effect in Maine since 1992 (DEP 2004). Monitoring sediments for pollutant concentrations, toxicity, and benthic community structure over time allows us to assess the extent and impacts of pollution contamination, and to measure the success of management strategies to reduce pollutant loads.

### Status

#### Contaminants

CBEP began monitoring the sediments in the Bay in 1991, conducting a baseline assessment at 65 sites. The site selection process took into consideration good areal coverage of the Bay, different sediment types and bottom communities, water depth, circulation patterns, and areas known to be historically affected by pollution. Surface sediments were analyzed for heavy metals, PAHs, PCBs and pesticides (Kennicutt *et al.* 1992). In 1994, 28 of the original sites and five new sites were analyzed for butyltins, doxins/furans,



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Bottom-dwelling organisms like lobsters are exposed to toxic chemicals in the sediments. DEP advises consumers not to eat lobster tomalley.

and coplanar PCBs (Wade *et al.* 1995). In 2000 and 2001, in partnership with EPA's National Coastal Assessment (NCA), CBEP resampled the sediments at the original locations for toxic pollutants, as well as for sediment toxicity and community structure. The results indicated that, in general, the most widespread contaminants in the Bay are petroleum and its byproducts, particularly high molecular weight PAHs derived from high-temperature combustion of petroleum products (*e.g.*, vehicle exhaust). The sampling also indicated that PCBs were highly elevated in the inner Bay near Portland; and that none of the pesticides measured was highly elevated in the Bay. Trace metals were generally highest in the Inner Bay but few samples were much elevated above background levels. Butyltins, dioxins/furans, and planar PCBs were found throughout the Bay, with the highest levels in the Inner Bay.

#### Toxicity

Based on CBEP and NCA sampling, the concentrations of metals, PCBs (at almost all sites), pesticides, butyltins, doxins/furans and planar PCBs are lower in Casco Bay than levels known to cause harmful effects to organisms. PAH concentrations in the inner part of the Bay were between the levels identified by the National Status and Trends Program (NST) as Effects Range Low (possible biological

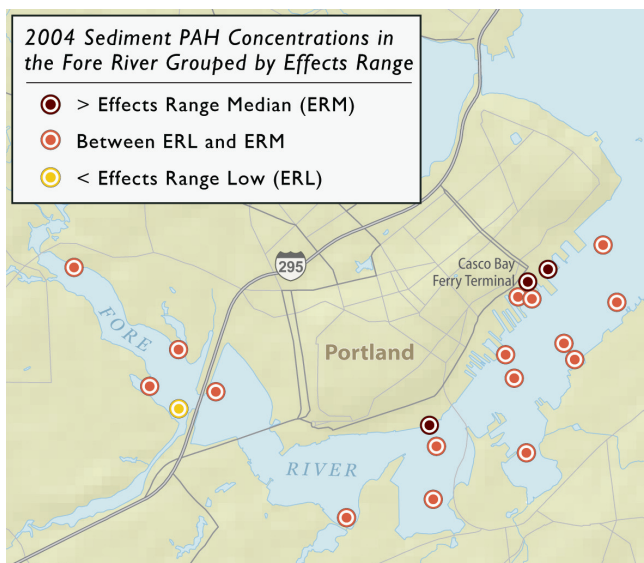


Sampling was conducted in 2004 in the Fore River by Friends of Casco Bay, supported by a Natural Resource Damage Assessment grant and funds from CBEP. Low and high molecular weight PAHs come from different sources, and their ratio can be used to help identify the likely source of the PAHs. For example, at the Casco Bay Ferry Terminal the primarily high molecular weight PAH signature indicates post-combustion sources such as vehicle exhaust and industrial combustion, rather than the low molecular weight signature of oil spills and urban runoff. The PAHs are likely carried via the CSO at the site (FOCB 2005).

effects) and Effects Range Median (probable biological effects) (Wade *et al.* 1995). The toxicity of additional PAH samples collected in the Fore River in 2004 is described in the map at right.

### Trends

Scientists from Texas A & M University compared the pollutant concentration data from the 1991/1994 Casco Bay sediment sampling to the 2000/2001 data. They concluded that most toxic chemicals decreased or stayed the same during that time period, indicating that pollution control strategies are working in Casco Bay (see the summary table to the right and the TBT maps; Wade and Sweet 2005). Since many toxic compounds decay very slowly – or not at all – in the sediments, it is assumed that the declining levels observed primarily reflect the burial of toxics by cleaner, more recent sediments. The NCA program and CBEP collected sediment samples again in summer 2010. When the results of the 2010 sampling are available, CBEP will fund an analysis of spatial and temporal trends from 1991 to 2010.



Change in Concentration of Toxic Chemicals from 1991/1994 to 2000/2001 in Casco Bay Sediments

Decreased	No Overall Change	Increased
Cadmium	Arsenic	Silver
Chromium	Copper	
Mercury	Lead	
Nickel	Zinc	
Selenium		
Total pesticides, 4,4-DDE, 4-4DDD and total DDTs		
Tributyl tin and total butyl tin		
Total PCBs		
Planar PCB 126	Planar PCB 77	
	Dioxins/Furans	
Low molecular weight PAHs	Total PAHs	High molecular weight PAHs

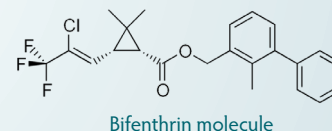
Source: Wade and Sweet 2005

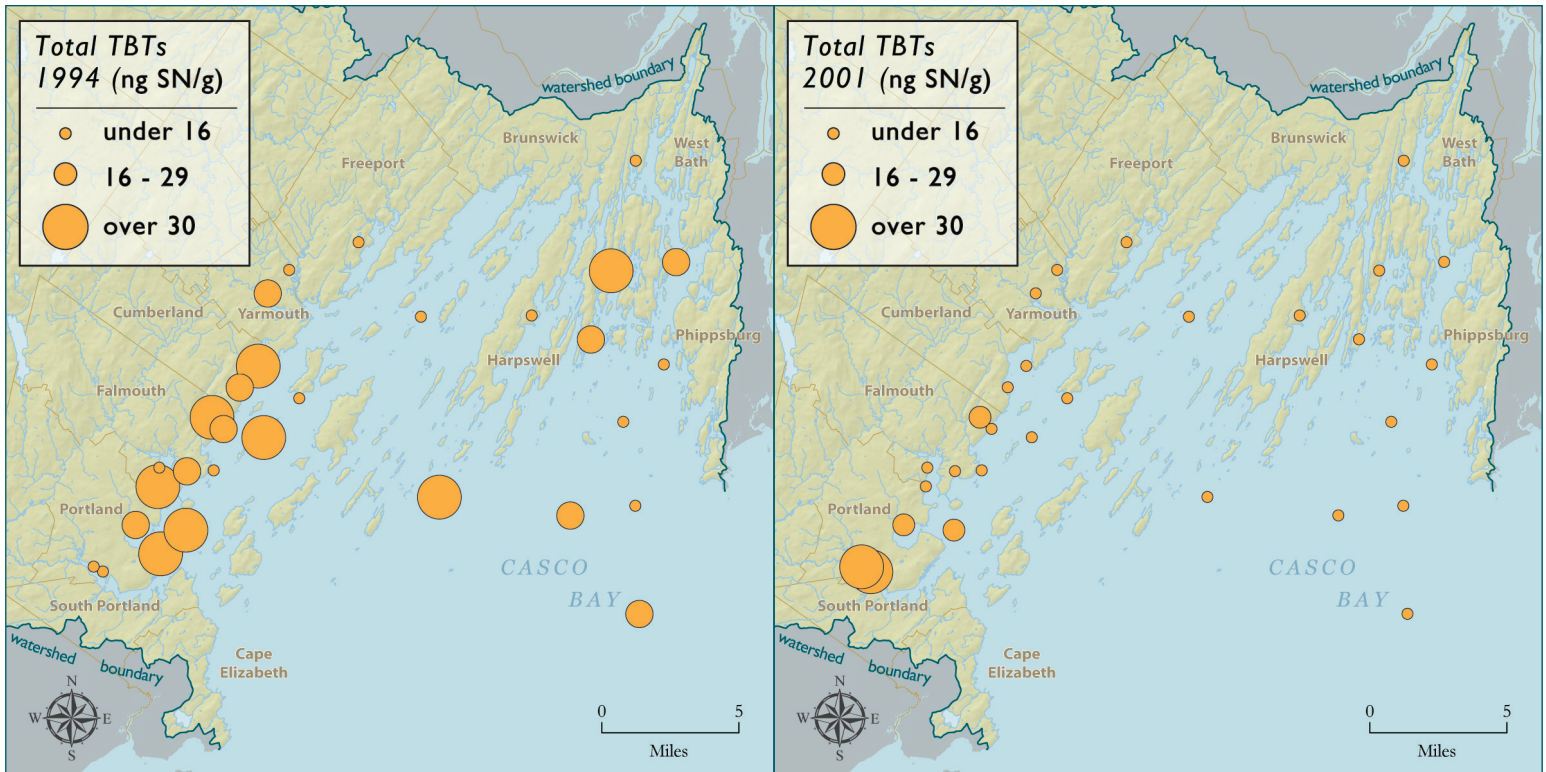
### PESTICIDE RUNOFF FROM URBAN AREAS

Maine Bureau of Pesticides Control (BPC) has been concerned about pesticides running off the land surface of urban watersheds into coastal sediments. In 2008 BPC analyzed sediment samples from Mussel Cove in Falmouth and Back Cove in Portland for pyrethroid pesticides, including bifenthrin. Pyrethroids are used in common household insecticides and are toxic to aquatic fish and invertebrates. (Commercially available products that include bifenthrin include Talstar, Capture, Brigade, Bifenthrine, Ortho Home Defense Max, and Scotts LawnPro Step 3.) Mussel Cove's intertidal mud flats are commercially harvested for soft-shell clams. Land use in the 5.4 square mile drainage area of Mill Creek, which empties into Mussel Cove, is both residential and commercial, especially along Route 1, where there are large areas of impervious surface. Land use in areas adjacent to Back Cove is

heavily residential and stormwater continues to discharge to the Cove. Back Cove, an important migratory waterfowl wintering and stopover area, also serves an important marine worm habitat (DEP 2005).

The results indicated that bifenthrin was present at detectable levels in samples from both sites, with the highest levels found at Payson Park (Back Cove) (BPC 2008). More extensive sampling will be needed to confirm the concentrations present and their potential for impacts to organisms. Pyrethroids were not found at detectable levels in mussels sampled by Maine DEP in the Mill Creek/Mussel Cove area in 2009 (see Indicator 9).





Tributyl tin (TBT) is an ingredient in marine anti-fouling paints. Federal and state laws now ban the use of paints with TBT for all uses except for vessels longer than 25 meters, or those having aluminum hulls (Maine DEP 1999). The overall decline of TBT concentrations in the Bay's sediments reflects the effectiveness of those laws at reducing toxic chemicals in the marine environment. The continued use of TBT paints on large commercial vessels may explain the continued presence of elevated TBT in the sediments of inner Casco Bay sites (Wade and Sweet 2005).

The results of the 1991/1994 and the 2001/2002 sampling were reported in more detail in both the 2005 *State of the Bay* report and the 2007 report *Toxic Pollution in Casco Bay*. The figure above illustrates an interesting pollutant management success story.

### Conclusions and Future Directions

Management strategies for reduction of pollution inputs in the Bay are having a positive impact. In addition to the observed declines in metals, PCBs and pesticides, the overall decline in low molecular weight PAHs in the Bay suggests that management strategies to reduce PAH inputs from spills and stormwater are working. The increase in high molecular weight PAHs, which are primarily a byproduct of combustion, is likely due to increased use of fossil fuels throughout the region.

CBEP will report on the long-term spatial and temporal trends in the concentration of toxic contaminants in the Bay's sediments based on sampling in 1991/1994, 2001/2002 and 2010, as soon as that analysis is ready. The results will be included in the 2015 *State of the Bay* report. In addition, data from the 2001/2002 and 2010 NCA

samples of benthic community structure will be analyzed to determine how pollutants are impacting the Bay's benthic organisms.

#### References

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